

WHAT IS CLAIMED IS:

1. An apparatus for heat treating semiconductor wafers comprising:

a thermal processing chamber adapted to contain a semiconductor wafer; and

5 a heating device in communication with said thermal processing chamber for heating a semiconductor wafer contained in said chamber, said heating device comprising:

10 (a) a plurality of light energy sources configured to emit light energy onto said semiconductor wafer, said light energy sources being positioned so as to form an irradiance distribution across a surface of said wafer; and

15 (b) at least one adjustable tuning device positioned amongst said light energy sources, said tuning device being configured to change the irradiance distribution of said light energy sources in a manner for more uniformly heating said semiconductor wafer.

2. A apparatus as defined in claim 1, wherein said tuning device comprises a light energy source spaced from at least one focusing lens, said focusing lens being configured to focus light energy being
5 emitted by said light energy source, said light energy source and said focusing lens being mounted to a support structure.

3. An apparatus as defined in claim 2, wherein said support structure is movable for directing light energy being emitted by said light energy source onto a determined location onto a determined location on
5 said semiconductor wafer.

4. An apparatus as defined in claim 1, wherein said tuning device comprises a laser diode, said laser diode being adjustable for directing light energy

5 being emitted by said laser diode onto a determined location on said semiconductor wafer.

5 5. An apparatus as defined in claim 1, wherein said tuning device comprises an optical element positioned adjacent to at least one of said light energy sources, said optical element being configured to redirect light energy being emitted by said plurality of said light energy sources for varying the irradiance distribution of said light energy sources for more uniformly heating said semiconductor wafer.

6. An apparatus as defined in claim 1, wherein said optical element includes a ruled prismatic surface for redirecting said light energy being emitted by said light energy sources.

7. An apparatus as defined in claim 6, wherein said optical element redirects said light energy being emitted by said light energy sources by reflecting said light energy.

8. An apparatus as defined in claim 5, wherein said optical element redirects said light energy being emitted by said light energy sources by refracting said light energy.

9. An apparatus as defined in claim 5, wherein said optical element includes a diffuse surface for redirecting said light energy being emitted by said light energy sources.

10. An apparatus as defined in claim 1, further comprising:

5 at least one temperature sensing device for sensing the temperature of said semiconductor wafer at least at one location; and

a controller in communication with said at least one temperature sensing device and at least certain of said light energy sources, said controller being configured to control the amount of light energy

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10 being emitted by said light energy sources in response to temperature information received from said at least one temperature sensing device.

11. An apparatus as defined in claim 1, further comprising a substrate holder for holding said semiconductor wafer, said substrate holder being configured to rotate said wafer.

12. An apparatus for heat treating semiconductor wafers comprising:

a thermal processing chamber adapted to contain a semiconductor wafer; and

5 a heating device in communication with said thermal processing chamber for heating a semiconductor wafer contained in said chamber, said heating device comprising a plurality of light energy sources configured to emit light energy onto said
10 semiconductor wafer, said light energy sources being positioned so as to form an irradiance distribution across a surface of said wafer, and at least one tuning device positioned amongst said light energy sources, said tuning device comprising a light source spaced from at least one focusing lens, said focusing
15 lens being configured to focus light energy being emitted by said light energy source onto a determined location on said semiconductor wafer in a manner that more uniformly heats said semiconductor wafer.

13. An apparatus as defined in claim 12, further comprising:

at least one temperature sensing device for sensing the temperature of said semiconductor wafer at
5 least at one location; and

a controller in communication with said temperature sensing device with at least certain of said light energy sources, and with said tuning device, said controller being configured to control

10 the amount of light energy being emitted by said light energy sources and said tuning device in response to temperature information received from said temperature sensing device.

14. An apparatus as defined in claim 13, wherein said controller is configured to control the amount of light energy being emitted by said at least one tuning device independently of said light energy sources.

15. An apparatus as defined in claim 14, wherein said at least one temperature sensing device senses the temperature of said semiconductor wafer at a plurality of locations.

5 16. An apparatus as defined in claim 12, wherein said light energy sources are positioned in concentric rings for heating different radial locations on said semiconductor wafer, said at least one tuning device being placed in between a pair of adjacent rings of light energy sources.

5 17. An apparatus as defined in claim 12, wherein said focusing lens and said light energy source are mounted to a support structure, said support structure being movable for directing light energy being emitted by said light energy source onto a determined location on said semiconductor wafer.

18. An apparatus as defined in claim 17, wherein said support structure comprises a tiltable lever arm.

19. An apparatus as defined in claim 12, wherein said apparatus contains at least three of said tuning devices.

20. An apparatus for heat treating said semiconductor wafers comprising:

a thermal processing chamber adapted to contain a semiconductor wafer; and

5 a heating device in communication with said thermal processing chamber for heating a semiconductor

wafer contained in said chamber, said heating device comprising a plurality of light energy sources configured to emit light energy onto said semiconductor wafer, said light energy sources being positioned so as to form an irradiance distribution across the surface of said wafer, said heating device further comprising at least one adjustable tuning device positioned amongst said light energy sources, said tuning device being configured to change the irradiance distribution of said light energy sources in a manner for more uniformly heating said semiconductor wafer, said tuning device comprising an optical element positioned adjacent to said at least one of said light energy sources, said optical element defining a surface configured to reflect light radiation being emitted by said light energy sources for varying the irradiance distribution of said light energy sources in a manner that more uniformly heats said semiconductor wafer.

21. An apparatus as defined in claim 20, wherein said optical element includes a ruled prismatic surface for reflecting said light radiation.

22. An apparatus as defined in claim 20, wherein said optical element includes a diffuse surface for reflecting and scattering light radiation.

23. An apparatus as defined in claim 22, wherein said diffuse surface comprises a rough surface.

24. An apparatus as defined in claim 21, wherein said ruled prismatic surface has a fixed pitch and a fixed facet angle.

25. An apparatus as defined in claim 21, wherein said ruled prismatic surface has a fixed pitch with a variable facet angle.

26. An apparatus as defined in claim 20, wherein said surface of said optical element is coated with a

highly reflective material having a reflectivity of at least 0.9.

27. An apparatus as defined in claim 20, further comprising:

at least one temperature sensing device for sensing the temperature of said semiconductor wafer at least at one location; and

a controller in communication with said at least one temperature sensing device and at least certain of said light energy sources, said controller being configured to control the amount of light energy being emitted by said light energy sources in response to temperature information received from said at least one temperature sensing device.

28. An apparatus as defined in claim 20, wherein the position of said optical element is adjustable with respect to said light energy sources.

29. An apparatus as defined in claim 28, wherein the height of said optical element is adjustable with respect to said light energy sources.

30. An apparatus as defined in claim 27, wherein said light energy sources are positioned in concentric rings and wherein said controller is configured to control the amount of light radiation being emitted by each of said concentric rings independent of the other of said rings.

31. An apparatus as defined in claim 20, further comprising a substrate holder for holding said semiconductor wafer, said substrate holder being configured to rotate said wafer.

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